TESTING FOR MARKET SHARE STABILITY AND CARTELS*

Aitor Ciarreta**

WP-AD 2002-17

Correspondence to Aitor Ciarreta, Departamento de Fundamentos del Analisis Economico, Universidad de Alicante, San Vicente del Raspeig, Alicante 03008, e-mail ciarreta@merlin.fae.ua.es

Editor: Instituto Valenciano de Investigaciones Económicas, S.A.

Primera Edición Octubre 2002

Depósito Legal: V-4031-2002

---

* I wish to thank my thesis adviser Prof. John Hause for suggesting me the main idea and his invaluable comments. Stefan Fölster and Sam Peltzman kindly provided me with the Swedish cartel data. I am also indebted to all the participants at the graduate student seminars at the State University of New York at Stony Brook, the Universidad del País Vasco at Sarriko, and Universidad Pablo de Olavide at Seville. All the errors of my entire responsibility.

** A. Ciarreta: Departamento de Fundamentos del Analisis Economico, Universidad de Alicante.

TESTING FOR MARKET SHARE STABILITY AND CARTELS

Aitor Ciarreta

ABSTRACT

One of the most challenging problems to applied industrial economists is the detection of colluding behavior in oligopolistic markets. In this paper we postulate how low market share variability may be used as a primary indicator of cartel success to maintain the agreed upon levels of production, after controlling from exogenous fluctuations in the economic environment and the market structure. To test this hypothesis we use a unique data set consisting of government-sanctioned cartels in Sweden from 1976 to 1990. The use of a measure of share stability is shown to be an interesting and potentially informative statistic for making comparisons when the cartel agreement is in effect and when it is absent. The conclusion supports our hypothesis that horizontal price fixing cartels are significantly associated with a lower instability than in its absence. The normative implication of the paper is that a measure of market share variability may provide a basic framework for antitrust authorities to call for attention on the possible existence of tacit collusion in industries with similar market structure but significant differences in market share stability.

Keywords: Industrial Organization, Antitrust Economics, Panel Data Analysis

1. Introduction

The problem of detection of colluding behavior in oligopolistic markets is an issue actively subject to both theoretical and empirical research by industrial economist, because the associated restrictive practices result in a misallocation of resources and a loss of social welfare as compared to the competitive solution. This is the reason why antitrust authorities laws condemn practices in restrain of trade or commerce, and antitrust agencies have been created to prosecute this kind of conspiracies[1]. There are a number of structural conditions that facilitate collusion, and therefore whenever we find markets in which these conditions are present we may conclude that it is conducive to collusion. Industrial organization theorist have identified among other factors product homogeneity, because it requires a less complex price structure to agree upon, fewness of sellers, because it reduces the coordination problem, high concentration, because it raises the awareness of mutual interdependence, and demand elasticity, the lower the elasticity of demand the higher the profits from increasing the price above the competitive levels, industry maturity, and concentration, that makes a market conducive to collusion. Thus, we should expect collusion to take place most often when these conditions are present. Despite the fact that these circumstances may play a relevant role[2], and are used by antitrust authorities to guide their actions, we propose a complementary approach based on market share variability. We will see how this approach can be used as a primary indicator of colluding behavior in oligopolistic markets.

Cartels face two kinds of problems, one is internal, and the other one is external. One of the internal problems of collusive behavior is in the distribution of the gains from participation, i.e. the sharing problem. Putting to one side the possibility of

---

[1] The US antitrust law was born in 1890 after the congress passed Sherman Act (1890). Following with the dissatisfaction for the lack of effectiveness of the act, new laws were passed on like the Clayton act and the Federal Trade Commission. The American law condemns per se any restriction to competition. In Europe the legal body was unified after the formation of the Union, the directions are compiled in articles 81 through 86 of the European Union treaty. The European legal framework distinguishes between those agreements that restrain competition and is efficiency enhancing and those that are not. Both legal systems have enforced exemptions to their antitrust laws. The exceptions are applied to those cases in which the public interest demands some coordination among firms to achieve it.

[2] See Hay and Kelley (1974), Palmer (1972), and Fraas and Greer

collusive price discrimination, one would expect successful collusion to restrict output to a lower level than would otherwise occur. The temptation of individual firms to deviate and increase their own profits by expanding their own output while others contract is a problem that successful collusion must solve, that is the problem of deterring cheating or non-compliance. If the ex-post profits were redistributed among the firms, this would reduce the temptation of ex-ante deviation. In the absence of ex-post redistribution of profits and informative market price on collusive behavior[3], some market sharing arrangement appears a natural way to share the profits from collusion.

The observation of a market price by itself tells us little about the competitiveness of the corresponding industry unless we observe prices in industries with similar cost structures. If we are able to accurately measure the marginal cost of the firms then we can estimate the price-cost margin and assess the state of competition in the industry. The temporal pattern of the industry price-cost margin might reveal changes in the competitive structure of the market. The price is subject to changes in the demand conditions, and the cost function of the firms change over time with innovation and the fluctuation of the price of the inputs. The main problem is that estimations of the marginal cost are rather complicated.

Cartels also face an external problem, namely the prediction of the production levels by domestic outsiders and, especially in the case of small open economies by foreign producers[4]. If the competitive fringe represents a small fraction of the total supply in the market then the external problem is alleviated, otherwise it should be considered as a source of potential instability. The existence of a significant competitive fringe increases the pressure on the collusive agreement.

---

[3] That seems to be the case in the Swedish cartel data used in the paper as we describe in section 3. Studies of the evidence of price increase around cartel formation and price decrease around cartel dissolution have not been entirely satisfactory; see Fölster and Peltzman (1997). Ciarreta (2000) finds significant evidence of price increase around horizontal formations and price decrease around cartel termination. In any case the econometric results are stronger for output changes around changes of cartel status.

[4] For a discussion see Jacquemin et al. (1980) in which they estimate a structural model of profitability for a data set of manufacturing industries in Belgium that incorporates foreign trade issues. They conclude that for small open economies neither total nor domestic concentration ratios are valuable indicators of market power for industries deeply involved in export and import competition. Stålhammar (1993) also justifies the inclusion of the foreign trade variables in his estimations of the degree of implicit collusion in the Swedish manufacturing firms.

In his seminal (1964) paper on oligopoly theory, Stigler argues that firms in an industry form a cartel to enforce monopolistic conduct in a self-policing way. He argues that among the different methods of collusion in cartels a joint sales agency is probably the most effective, followed by output fixing and price fixing. The traditional theories of collusion emphasized the role of market concentration and the extent to which substitute goods are available in industries without entry to determine successful collusion. On the contrary Stigler emphasizes the role of secret -price cutting and how fixing market shares, if feasible, is likely to be the most efficient way of combating behavior that undercuts the cartel. Osborne (1976) in a static model proposes a reaction function equilibrium in which firms respond to changes in output by other firms in order to maintain their proportionate share of industry output. Friedman (1971) in a supergame theoretic framework also studies deviations by the colluding firms from the agreed-upon levels of output to detect cheating.

But another models have been developed to show how some markets with these characteristics are not necessarily more conducive to colluding behavior. Geroski (1982) discusses the nature itself of the structure-performance approach. After demonstrating that conventional structure-performance theory does not generate conventional looking causal links, discusses the antitrust implications of this argument. First, antitrust policy is conceived as manipulation of the market structure in the hope of an amelioration of performance, but this view is not undoubtedly founded in structure-performance models, and the model itself determines structure and not the effects of changes in structure. Second, while the model itself may not justify structural intervention, it may be used to guide it. It is more promising to derive rules from the data. Donsimoni et al (1984) also argue how concentration indices can be useful in assessing the state of competitiveness in markets.

We have focused our discussion on horizontal price fixing or market sharing cartels. Vertical restraints are long-term contracts between suppliers and users to reduce the cost of their transactions. But vertical restraints may reduce demand variability as felt by suppliers and therefore exhibit lower market share variability. The argument is as follows. Variability in demand implies costs, there are three sources of demand variability suffered by a supplier: fluctuations in market demand, fluctuations in the market share of a customer, and fluctuations due to shifts in suppliers by a customer. Vertical restraints reduce the potential instability arising from the fluctuations in the price of the inputs, thus cost functions, and therefore the supply function are less unstable. That mechanism of stability is transmitted to the market shares.

We can conclude that the market share and its intertemporal variation may be a primary indicator of successful collusion for the firms in a noncooperative equilibrium framework. The firms in a successful cartel will have lower variability, ceteris paribus. We do not impose any assumption on the type of collusive agreement that firms may reach; therefore a whole spectrum of collusive models is included[5]. Without a formal model, we identify structural factors that influence the stability of the equilibrium shares through the causes that disturb the short run equilibrium. The instability of market shares provides a measurable indicator of rival's behavior in oligopolistic markets. Stability indicates the completeness of the oligopolistic bargain process[6]. If we control for all the relevant factors that perturb the equilibrium, an analysis of the determinants of market share variability provides a promising framework to understand how market structure affects oligopolistic behavior.

The closest work to ours is the one by Caves and Porter (1978), Gort (1963), Heggestad and Rhoades (1976), Jacoby (1964), Mann and Walgreen (1970), and Ogur (1976) also supports the use of a measure of market share instability. Our approach is different in several ways. First, in the way we construct the measure of market instability. As we will show in section 3, it takes into consideration all the possible ratios of market share fluctuation between two periods among all the firms in the market. Second, our data consists of a panel of government-sanctioned cartels, thus it allow us to run an experiment knowing that a cartel was formed and then test for the instability of the shares. Third, we wish to approach the problem without imposing a structural model underlying the results.

The paper is organized as follows. Section 2 studies the determinants of market share variability. Section 3 explains the construction of the dependent variable used to measure variability and its computation for the sample under stud, and the independent variables. Section 4 statistically analyzes the results. Section 5 contains the econometric results. Section 6 concludes and discusses the normative implications of the approach.

---

[5] Stigler (1964) also asserts that oligopolists wish to collude to maximize joint profits. In the absence of side payments that might not be entirely true. There are actually many possible collusive prices between the non-collusive equilibrium price and the joint-profit maximizing one. The theory of repeated games has shown how we can find equilibrium strategies to sustain those prices.

[6] Stability should also be a characteristic of competitive markets. We expect that in highly concentrated markets firms are aware of their interdependence and consider it in their optimal behavior.

2. Determinants of market share variability

A variation over time of the market shares of oligopolistic competitors signals a disturbance in the short run equilibrium of quantities. In the new equilibrium some firms will have a higher market share than others, also some firms may exit and new ones supply the market. An oligopolistic model of equilibrium shares should be able to compile those factors and generate predictions over the way the market structure will evolve. A complete model of such complexity is not available but important steps have been taken in that direction[7]. The lack of such kind of models forces us to establish taxonomy of factors that may explain why the observed market share variability is evolving in that way. A complete description should contain the following components: What are the exogenous disturbances to the equilibrium outside the scope of the firms? How is the transition from the old to the new short run equilibrium? What is the frequency of the perturbations to the equilibrium? How much is the scope of the firms to internalize disturbances?

Let us consider first exogenous disturbances to the existing market structure. Exogenous disturbances that are reflected in industry sales variability may be the result of shifts in the demand by domestic or foreign consumers and/or changes in the cost conditions facing the firms. Demand growth and changes in the preferences of buyers are among the factors that shift the demand function. Entry of new competitors and exit of old competitors shift the supply function by changing the number of competitors in the market. In the absence of vertical coordination with input suppliers, a change in the price of inputs changes the supply curve by shifting the individual supply curves of all the existing producers. Investments in R&D shift downwards the cost function of the successful firms. Disturbances coming from foreign markets are typically outside the control of the domestic firms especially when we consider a small open economy. Multiproduct issues add further complexity since it is possible that some production processes can be switched to another line of product without relevant extra costs of replacing.

The relevance of the exogenous perturbations for the study of the equilibrium of market shares can be analyzed under two perspectives. The first one is that the response of the firms to those disturbances may be asymmetrical depending on the way they are

[7] For example Fershtman and Pakes (2000) for a dynamic model of cartel.

affected, thus leading to a new equilibrium. For example a shift in the preferences of the buyers toward an imperfect substitute good or an improvement in the technology of one firm will increase the market share of the firm that produces the good or innovates respectively. The second one is that even if the disturbance should a priori affect symmetrically to all the firms, the process of adjusting from the old equilibrium to the new one, may break down the oligopolistic understanding. An example is a decrease in industry demand, all the firms may be equally harmed from a contraction in the demand, but it is possible that in colluding markets the consensus breaks down if the firms cannot distinguish a period of recession from cheating by someone[8]. If the firms have access to the same information and firms produce homogeneous products disturbances from the demand side can be treated as uniform.

The scope for adjustment of the firms may be restrained by some market structure characteristics and the firms' internal organization itself. The firms' cost structure determines their capacity to respond to changes in the industry demand. If a firm operates in the neighborhood of full capacity or the marginal cost rises sharply at that level, we expect that the scope for adjustment to disturbances reduce significantly. The adjustment process takes time, if the firms are capable to take action quickly then the scope for adjustment in enlarged.

Product differentiation has an ambiguous effect. On the one hand, product differentiation implies less than infinite cross demand elasticities therefore market shares will not fluctuate as much as if the product was homogeneous, there is a switching cost by consumers. On the other hand product differentiation induces firms more easily to break the consensus because of the effective market power.

The institutional framework may play a significant role as well. The imposition of restrictions to competition under the form of regulation implies that firms may not be able to adjust to the equilibrium the way the will if those restrictions were absent.

The theory of cartels in oligopolistic markets identifies conditions conducive for cartels to be more or less stable. Consider a cartel that maximizes joint profits. The agreement also includes some kind of cost-minimizing rule to split market shares. That

---

[8] See the classic papers by Rotemberg and Saloner (1984) and by Green and Porter (1986). Whereas the former concludes that implicitly colluding oligopolies are likely to behave more competitively in periods of high demand. The latter concludes that collusion is more likely to be sustained in periods of high demand.

distribution will be revised in the event of some kind of disturbance. We expect that as the degree of completeness of the collusive agreement reduces the market share instability increases.

Competition in other nonprice market variables complicates the cartel effectiveness to maintain the agreed upon levels of output. Firms may compete in non-price and output variables to attract consumers, therefore maintaining the consensus becomes more costly, the completeness of the oligopolistic bargaining less complete, and instability raises.

3. Variables in the analysis

The dependent and independent variables are drawn from a Swedish data set consisting of 99 products in the manufacturing industry covering the period from 1976 to 1990, thus we have 1485 observations. The data comes from two different sources. The variables containing the type of cartel agreement come from the SPK, the Swedish cartel register, where cartels were publicly registered upon request. The rest of the variables come from the SCB, the Swedish Statistical agency.

The data has strengths and weaknesses. We start with the strengths. The data is unique because it contains cartel agreements that were publicly registered, i.e. cartels were legal and very few exemptions were included[9]. Furthermore it is quite representative of the overall Swedish manufacturing industry and has a time-series dimension that some of the previously mentioned studies lack. This fact allows us to observe the time pattern of the variables over a reasonably long time horizon.

The weaknesses of the data stem from the fact that we concentrate on manufacturing industries where departures from competition are constrained by foreign competition. About the cartel register, it is apparent how some agreements may not have been registered, and some others may have been remaining in the register after their actual termination. Therefore some of the predicted effects of the cartel will happen in

[9] The cartel legislation was in effect until 1993 when Sweden joined the European Union and the previously mentioned guidelines were adopted.

product-markets actually not registered as such, and absent in another markets in which they should.

Dependent Variable

We continue explaining the way the dependent variable was constructed. Consider first the case when there are two firms with market shares S_{1t} and S_{2t} in period t[10]. The following statistic, denoted as z_t, measures the relative intertemporal variability of the market shares of firms,

$$Z_t = \left| \mathrm{Ln} \frac{S_{1t+1} / S_{2t+1}}{S_{1t} / S_{2t}} \right|$$

To illustrate Z_t if the relative shares of the firms over the two periods are constant, then z_t equals zero. If there are more than two firms in the industry, one can use as the statistic of interest the average of all distinct pair-wise values of z_t for each period *t*,

$$Z_t = \frac{2}{N(N-1)} \sum_{i<j} \left| \mathrm{Ln} \frac{S_{it+1} / S_{jt+1}}{S_{it} / S_{jt}} \right|$$

Because we are interested in distinguishing cartelized from noncartelized periods, we can average z_t over the cartel and the non-cartel years,

$$\overline{Z}^{c} = \frac{1}{T^{c}} \sum_{t \in T^{c}} Z_t$$

$$\overline{Z}^{nc} = \frac{1}{T^{nc}} \sum_{t \in T^{nc}} Z_t$$

[10] If the firms sell homogeneous products, then we can equivalently use the intertemporal variation of the ratio of the quantities of the firms, q_{1t} and q_{2t} respectively, to construct the statistic, since the total output Q is in both the numerator and the denominator. That seems to be the case of the data since it has been selected from the SNI at the six-digit level.

By taking a product, and comparing the mean z over periods in which there was a cartel agreement with the mean over periods in which there was no cartel agreement, we have a basic statistical framework for testing the hypothesis whether the cartel agreement is associated with less relative market share variability[11].

Independent Variables

Variations in the industry sales tend to destabilize market shares. If the fluctuations do not uniformly affect all the firms in the market, then big increases and big decreases in sales should be associated with greater market share instability. An exogenous perturbation in the industry demand provokes a shift in short run oligopoly equilibrium that requires a new adjustment of the consensus and may cause defection of the colluding firms during the process.

Several studies find a negative relationship between market share (independent variable) and sales variability (one of the dependent variables)[12]. Furthermore, they find a positive relationship between industry sales variability and sales variability.

ISVAR: Absolute value of the change in the industry sales. The variable R_{it} includes both the supply by local producers and the values of the import in market *i* in year *t*.

$$ISVAR_{it} = \left| \ln\left(\frac{R_{it+1}}{R_{it}} \right) \right|$$

It is of interest to distinguish between downturns and upswings in the economy. If price wars are more (less) likely during periods of economic growth we might observe higher (lower) variations in the market shares of the firms during those periods as well.

---

[11] We can also consider the inclusion of a correction for the initial size in the dependent variable to account for differences in the initial market share. We want to check whether there is a significant higher fluctuation in the dependent variable in those markets in which the initial asymmetry in the market shares is bigger.

[12] Das et al. (1993), Scherer (1970), and Mills and Schumann (1985).

GROWTH: Dummy variable that takes value one if there is an increase in the demand and zero otherwise[13].

$$\text{GROWTH}_{it} = \begin{cases} 1 & \text{if} \quad \ln\left(\dfrac{R_{it+1}}{R_{it}}\right) > 0 \\ 0 & \text{ow} \end{cases}$$

Significant entry and exit of firms in the market necessarily perturbs the short run equilibrium. The existent barriers to entry regulate entry of new firms. Entry not only automatically decreases the market shares of the existing firms but may also upset the equilibrium by intensifying the best response efforts of the existing firms. On the contrary exit increases the market shares of the existing firms, therefore increases concentration and the best response effort of the firms is a priori easier.

ENTRY: Dummy variable that takes value one if there is entry by one firm that gets at least 10 percent of the market share

$$\text{ENTRY}_{it} = \begin{cases} 1 & \text{if} \quad N_{it} - N_{it-1} > 0 \\ 0 & \text{ow} \end{cases}$$

EXIT: Dummy variable that takes value one if there is exit by one firm that had at least 10 percent of the market share

$$\text{EXIT}_{it} = \begin{cases} 1 & \text{if} \quad N_{it} - N_{it-1} < 0 \\ 0 & \text{ow} \end{cases}$$

Import competition should increase market share instability. The effect is similar to that of entry by new firms. Foreign producers by selling in the domestic market introduce an exogenous perturbation that tends to break the oligopolistic consent by increasing the competitiveness in the market.

IMPORT: Absolute value of the variation of the share of the imports from total domestic sales denoted as η_{it}, i.e. including sales by local firms and imports.

---

[13] We can alternatively use the slope coefficient of the log-linear regression of industry sales on time. Explore this possibility.

$$\text{IMPORT}_{it} = \left| \ln\left(\frac{\eta_{it+1}}{\eta_{it}} \right) \right|$$

It is a fact that there are market linkages beyond the national boundaries. The relation is quite complex. An average firm will sell to the domestic market and to foreign markets as well. Interdependence may be recognized less fully with foreign producers than local ones, especially when the exporting firms are of small size and the national market is concentrated. The presence of exports would be related with lower market share variability. There are two effects that operate in opposite directions. On the one hand market share variability may increase when tension among local producers is deviated outside the national boundaries. On the other hand exogenous perturbations may have the same effect as imports, decreasing market share variability.

EXPORT: Absolute value of the variation of the share of the exports from industry's total sales denoted as ϕ_{it}, i.e. sales to the domestic market and foreign markets.

$$\text{EXPORT}_{it} = \left| \ln\left(\frac{\varphi_{it+1}}{\varphi_{it}} \right) \right|$$

We distinguish between vertical (V) and horizontal (H) agreements. The data contain two types of horizontal agreements, market sharing and price fixing. Vertical agreements are basically exclusive dealing contracts. We expect that market-sharing agreements reduce market share variability. If cooperation is successful firms will produce splitting the markets and trying to maintain their quotas. Therefore fluctuation due to more intense competition will be lower. Price-fixing agreements may have the same stabilizing effects on market shares provided that potential gains on cost reduction by any cartel member does not break the agreement. Vertical restraints associated with exclusive dealing do not necessarily have a special role in reducing market share variability, since it involves intra-industry coordination. The presence of both types of agreements does not a priori shed light on the effects on stability.

HOR: Dummy variable equals one if there is any kind of horizontal restraint.

HORMS: Dummy variable equals one if there is a horizontal market sharing agreement

HORPF: Dummy variable equals one if there is a horizontal price-fixing agreement

VERT: Dummy variable equals one if there is a vertical exclusive dealing agreement

BOTH: Dummy variable equals one if there is both any kind of horizontal and vertical agreements

The only structural variable we can use is a rough measure of the variation in the capital intensity using the capital stock to the sales ratio as variable. The steeper the marginal cost curve, the closer to full capacity the production plant, therefore the expansion possibilities are limited. Share instability is negatively associated with capacity utilization.

KSR: Capital intensity variation: absolute value o the logarithm of the yearly variation of stock of capital to net sales ratio, denoted as ψ_{it}.

$$KSR_{it} = \left| \ln\left(\frac{\psi_{it+1}}{\psi_{it}} \right) \right|$$

Variables indicating oligopolistic behavior are also included to consider for the high concentration in all the markets in the data. That fact partly reflects a small economy effect, by which only few producers can survive. But it is significant how cross-country studies reflect that the Swedish industry is remarkably concentrated. We measure concentration by the Herfindahl index, the sum of the squares of all the firms in the industry. Then we want to see the effect of changes in concentration on instability.

HHI: absolute value of the logarithm of the yearly change in the Herfindahl index, denoted as h_{it}.

$$HHI_{it} = \left| \ln\left(\frac{h_{it+1}}{h_{it}} \right) \right|$$

Entry and exit are highly correlated with the Herfindahl index. If everything remains the same, entry should decrease concentration whereas exit increases it. Entry is in general more likely to be associated with low structural barriers and hence with lower concentration.

4. Statistical results

Table I provides with descriptive statistics of interest of the independent variables, namely the average, standard deviation, minimum and maximum values, and a brief description of the previously discussed variables to be used in the econometric analysis that follows.

Table I. Descriptive statistics of the independent variables

Variable	*Description*	*Mean*	*Std Dev.*	*Min*	*Max*
ISVAR	Absolute value of the logarithm of the ratio of the sales between two periods	0.032	0.024	0	0.175
GROWTH	Dummy variable =1 if ISVAR is greater than zero	0.758	0.429	0	1
ENTRY	Dummy variable =1 if there is entry of a new firm in the market	0.014	0.118	0	1
EXIT	Dummy variable =1 if there is exit of a firm in the market	0.013	0.115	0	1
IMPORT	Absolute value of the logarithm of the ratio of import share from total domestic sales between two periods	0.072	0.189	0	2.672
EXPORT	Absolute value of the logarithm of the ratio of export share from total industry sales between two periods	0.051	0.058	0	0.786
HOR	Dummy variable =1 if there is any kind of horizontal restraint	0.063	0.242	0	1
HORMS	Dummy variable =1 if there is a market sharing agreement	0.045	0.208	0	1
HORPF	Dummy variable =1 if there is a horizontal price-fixing agreement	0.129	0.335	0	1
VERT	Dummy variable =1 if there is a vertical cartel (exclusive dealing)	0.075	0.263	0	1
BOTH	Dummy variable =1 if there are both horizontal and vertical agreements	0.119	0.323	0	1
KSR	Absolute value if the logarithm of the yearly variation of the capital to sales ratio	0.031	0.028	0	0.266
HHI	Absolute value of the logarithm of the yearly variation of the Herfindahl index	0.029	0.088	0	0.693

The mean values of the dummy variables are easy to interpret; it is nothing but the percentage of observations with a value one. For example 7.5 percent of the 1485 observations had vertical restraints to competition. To illustrate some the rest of the values consider for simplicity the case with two firms. Let's assume that the sales variation between two periods t and $t+1$ is equal to the mean, that means that if there is positive (negative) variation in the total industry sales then there is a 4.5 percent relative increase (decrease) in the market share of firm 1 relative to firm 2.

Before we turn the attention to the dependent variable we want to emphasize how the Swedish manufacturing industry is highly concentrated. First, for the sample under study the average Herfindahl index is 0.40 and ranges from 0.25 to 0.74, in few cases it is even 1. Besides the number of firms is never bigger than 4. Second, entry and exit of firms seem not to have played a significant role in the evolution of the market structure; the table shows that during the entire sample period there were only 21 new entries and 20 exits of firms for a total of 229 firms, but the Herfindahl index remained stable over time. The correlation coefficient between HHI and ENTRY is –0.07, which means that even though it is negative, it is almost zero. New entry does not play a significant role in decreasing concentration. Third, there are markets entirely sheltered from international competition.

We cannot underestimate the importance of the cartel variables. We proceed with a cross-section study of the cartel frequency and type by sector of production for the whole sample, using product-years as the unit of measure. Results are reported in Table II. The product-years are the result of multiplying the number of goods times the number of years the cartel existed. Three broad categories of cartel agreements are considered: horizontal, vertical and both types of agreements. Column 3 is the percentage of product years under any type of cartel agreement. The rest of the columns are the percentage of the product years under the indicated type of agreement.

It is the case that 41 out of the 99 products have experienced at least one change in their cartel registration status. The table reveals that some form of cartel agreement covers 26 percent of the sample. The data allow us to distinguish horizontal (primarily price-fixing and market sharing contracts) from vertical (exclusive-dealing contracts) agreements. Around 40 percent of the agreements contain both vertical and horizontal

Table II. Cartel frequency and type by industry

Sector	*Product Years*				
	Total	**With cartel**	**Only vertical**	**Only horizontal price fixing**	**Both types**
Food	150	113	4.66	10.66	60
Apparel and leather	60	20	0	33.33	0
Wood and paper	135	54	11.85	13.33	11.85
Packaging	45	23	0	28.88	22.22
Chemicals	105	43	0	21.90	19.04
Drugs and cosmetics	60	9	0	5	10
Petroleum products	60	6	10	0	0
Rubber	45	0	0	0	0
Stone, clay and glass	135	19	14.07	0	0
Metal	165	0	0	0	0
Machinery	120	18	0	0	15
Electronics	210	14	6.66	0	0
Transport equipment	105	15	14.28	0	0
Miscellaneous	90	47	38.88	0	13.33
Total	**1485**	**381**	**7.17**	**8.08**	**10.81**

restraints. Only two sectors of production, rubber and metal have not experienced any episode of cartelization during the period under study[14].

A significant feature of the data is the concentration of the total cartel activity by industry, and particularly in the food sector with 37 percent. Considering the aforementioned fact that in the food sector some of the cartels were government-enforced, it partially obscures the private costs of cartel enforcement. The wood and chemical sectors account for another 20 percent of the cartel activity. This feature reflects the tendency of the Swedish economic policy of protection towards those sectors traditionally important in the economy[15].

The available data impose limitations on the types of agreements that can be studied. There are many cartels with different types of terms registered at the same time, for example we find simultaneously price fixing and vertical restraints, market sharing

[14] But it is still possible that before 1976 those products had episodes of cartelization but already broke down by that time.

[15] An important exception is the ship building industry although it is not part of the data under study. That industry was traditionally very important in the Swedish economy with a world market share of 10 percent in the 1970s (the second largest in the world after Japan) to almost its entire disappearance ten years later. See Hollingsworth, Schmitter, and Streeck (1994).

and vertical restraints, and the three together. The data do not contain agreements that are just market sharing, they come in combination with price-fixing and exclusive dealing.

As long as the dependent variable is concerned, we use the real product sales (taking 1976 as the base year) of the firms as the proxy for the quantity, which is not restrictive since the products are fairly homogeneous (seven digit level in the SIC). Sales include export as well as domestic sales and there is no way we can distinguish how much go to the local market and how much go to the foreign market. Table III shows the dependent variable's mean and standard deviation by sector. We distinguish periods subject to cartelization from periods of oligopolistic competition. We also consider a simple F-test for the significance in the difference of the means of the two groups[16].

Table III. Means and standard deviations of measures of market share variability by sector

SECTOR	***Measure of Share Variability***				***Difference***
	With Cartel		**Without Cartel**		
	Mean	*Standard Deviation*	*Mean*	*Standard Deviation*	
Food	0.086	0.086	0.093	0.125	-0.007
Apparel and leather	0.067	0.048	0.052	0.062	0.015
Wood and paper	0.071	0.064	0.096	0.164	-0.025
Packaging	0.059	0.087	0.078	0.081	-0.019
Chemicals	0.094	0.089	0.061	0.079	0.033*
Drugs and cosmetics	0.143	0.066	0.071	0.074	0.072**
Petroleum products	0.176	0.120	0.061	0.068	0.115***
Rubber	…	…	0.073	0.084	…
Stone, clay and glass	0.063	0.051	0.114	0.100	-0.037*
Metal	…	…	0.096	0.170	…
Machinery	0.045	0.035	0.095	0.088	-0.05**
Electronics	0.119	0.161	0.084	0.095	0.024
Transport equipment	0.057	0.045	0.113	0.146	-0.089**
Miscellaneous	0.090	0.065	0.163	0.157	-0.073**
Total	0.082	0.083	0.087	0.120	-0.005

*Significant at 10% level
**Significant at 5% level
***Significant at 1% level

[16] We regress Z on a constant and a dummy for the cartel agreement by product, then run a F-test for its significance. This is just a simple test of structural change. Rejection of the null hypothesis means that there are no significance differences when cartel agreements were operating.

At an aggregate level there are no significant differences between the market share variability of the cartelized periods vs. the non-cartelized periods. At a sector level we can see that the frequency of significant negative differences (smaller mean market share variability for the cartel years) is marginally higher than the frequency of positive differences, which partially supports the postulated hypothesis. Furthermore the whole sample contains products in which there was no episode of cartelization, products that were covered by some kind of cartel agreement during the entire sample period, and products only affected by cartelization during some periods.

We proceed in the same way by constructing the dependent variable mean and standard deviation for every product that was subjected to cartelization at least for five years. In the empirical work we use a subsample of 24 products. The data was chosen in such a way that there was a cartel agreement during some periods and no cartel during the others for each product. The span of life of the cartels under study ranges from 3 to 12 years with an average of 7.5 years.

Then we test for the differences in the mean under the two groups. Support to our hypothesis should be reflected in significant positive differences between the mean periods without cartel and with cartel**.** Results are reported in Table IV (standard deviations are in parentheses).

At an aggregate level there are no significant differences between the market share variability of the cartelized periods vs. the non-cartelized periods. At a product level we can see that the frequency of significant negative differences (smaller mean market share variability for the cartel years) is higher than the frequency of positive differences, which partially supports the postulated hypothesis.

The table includes all the agreements without considering the changes in the economic environment before and after the mid-eighties, a period characterized by macroeconomic instability as pointed out before. This is why we require an econometric analysis that accounts for other determinants discussed previously.

Finally we also construct the Z-statistic for a subsample of horizontal price-fixing cartels since our conjecture considers these and market-sharing agreements as the agreements in which we observe lower market share instability. Results are reported in Table V.

Table IV. Computation of the Market Share Variability Statistic by Product♦

Product	*Cartel Period*	$\overline{Z}$ *no cartel*	$\overline{Z}$ *cartel*	*Diff.*	*Product*	*Cartel Period*	$\overline{Z}$ *no cartel*	$\overline{Z}$ *cartel*	*Diff.*
Margarine	1976-1981	0.063 (0.024)	0.153 (0.069)	-0.09***	Plastic Container	1976-1978	0.061 (0.029)	0.197 (0.162)	-0.136*
Rye Bread	1976-1979	0.068 (0.048)	0.236 (0.035)	-0.168***	Fertilizer	1976-1980	0.07 (0.046)	0.229 (0.101)	-0.159***
Mineral Water	1983-1990	0.201 (0.27)	0.048 (0.035)	0.153	Viscous fiber	1976-1981	0.028 (0.025)	0.05 (0.027)	-0.022***
Soft Drinks	1983-1990	0.092 (0.066)	0.062 (0.045)	0.03	Polyester lacquers	1976-1984	0.022 (0.017)	0.065 (0.04)	-0.043
Costumes of Wool	1976-1979	0.029 (0.031)	0.054 (0.071)	-0.025	Toilet soap	1976-1978	0.03 (0.029)	0.117 (0.031)	-0.087**
Shirts of Wool	1976-1984	0.055 (0.02	0.068 (0.065)	-0.013	Hairspray	1976-1981	0.052 (0.023)	0.153 (0.077)	-0.101***
Furniture leather	1976-1980	0.066 (0.048)	0.093 (0.055)	-0.027	Heating oil	1976-1981	0.035 (0.02)	0.176 (0.12)	-0.141***
Windows	1983-1990	0.09 (0.064)	0.055 (0.038)	0.035	Mineral Wool Insulation	1980-1990	0.124 (0.039)	0.063 (0.051)	0.061***
Typewriter paper	1979-1990	0.416 (0.558)	0.088 (0.08)	0.328**	Plough	1982-1990	0.1 (0.032)	0.032 (0.028)	0.068*
Newsprint paper	1981-1990	0.304 (0.347)	0.074 (0.052)	0.227**	Tractors	1982-1990	0.2 (0.137)	0.057 (0.038)	0.143***
Diapers	1976-1983	0.045 (0.051)	0.096 (0.098)	-0.051	Silver cutlery	1982-1990	0.244 (0.144)	0.096 (0.053)	0.148***
Glass Containers	1981-1990	0.142 (0.149)	0.044 (0.054)	0.098***	Electronic	1976-1987	0.028 (0.018)	0.087 (0.066)	-0.059
					TOTAL		**0.082 (0.119)**	**0.086 (0.075)**	**-0.004**

($\bar{z}$ denotes average of z)

Table V. Computation of the Market Share Variability Statistic for Price-Fixing Cartels

Product	*Cartel Period*	$\overline{Z}$ *no cartel*	$\overline{Z}$ *cartel*	*Diff.*	*Product*	*Cartel Period*	$\overline{Z}$ *no cartel*	$\overline{Z}$ *cartel*	*Diff.*
Mineral Water	1983-1990	0.201 (0.27)	0.048 (0.035)	0.153	Newsprint paper	1981-1990	0.146 (0.231)	0.118 (0.021)	0.028**
Soft Drinks	1983-1990	0.092 (0.066)	0.062 (0.045)	0.03	Diapers	1976-1983	0.045 (0.051)	0.096 (0.098)	-0.051
Costumes of Wool	1976-1979	0.029 (0.031)	0.054 (0.071)	-0.025	Plastic Container	1976-1978	0.057 (0.031)	0.289 (0.050)	-0.232*
Shirts of Wool	1976-1984	0.055 (0.02	0.068 (0.065)	-0.013	Viscous fiber	1976-1981	0.028 (0.025)	0.05 (0.027)	-0.022***
Furniture leather	1976-1980	0.066 (0.048)	0.093 (0.055)	-0.027	Polyester lacquers	1976-1984	0.036 (0.025)	0.086 (0.060)	-0.05
Windows	1983-1990	0.071 (0.053)	0.067 (0.057)	0.004	Toilet soap	1976-1978	0.03 (0.029)	0.117 (0.031)	-0.087**
					TOTAL		**0.085 (0.105)**	**0.081 (0.070)**	**0.04**

At an aggregate level there are no significant differences between the market share variability of the periods with horizontal agreements vs. the periods without agreement. The descriptive statistical analysis does not shed further light on the issue. We proceed by considering the determinants of market share variability described previously.

5. Econometric results

We consider a linear regression equation to study whether the choice of the organizational form of the cartel and the other exogenous determinants significantly affect the market share variability in the predicted way. We are not only interested in the sign of the predictions but also the magnitude of the effects. The regression equation takes the form[17]

[17]The model was also estimated using the components of the demand, i.e. industry sales and imports, the two variables are constructed the same way as the demand variability. The estimated coefficients were not significant.

$$Z_{it} = \alpha_0 + \Gamma'\Theta + B'X + \sum_{t=1}^{14} \delta_t + \varepsilon_{it}$$

where Θ is the matrix of dummies and X is the matrix with the rest of the independent variables. We also include time dummy variables δ_t to account for time specific effects. We estimate the full sample model using a generalized least squares regression model with a correction for heteroskedasticity as it was detected by a White test.

The estimation results using different sets of regressors and for the two sample sets discussed in the previous sections are reported in Table VI (next page). First, let's comment the properties of the results. A Wald test does not reject the null hypothesis of the joint significance of the regressors. The log likelihood value is higher for the whole sample than for the subsample.

It is noteworthy that no matter whether we consider the whole sample or the subsample, horizontal price fixing types of cartel agreements are significantly associated with lower market share variability. These result supports our postulated hypothesis on the stabilizing effects of this type of restrain to competition.

Regarding the other types of restrictions the results are not that clear. Vertical types of cartels do not significantly reduce market share variability and we can even observe higher instability than in their absence. Most of the agreements are exclusive dealing; these agreements do not necessarily reduce intra-industry competition and therefore coordination on market shares might not be part of the cartel objective.

The results on the effects of the regressors classified as exogenous disturbances are not always as we predicted and they even depend on the sample we consider. Industry sales variability does not significantly increases market share variability when the whole sample is considered but it does it when the sub sample is considered at the 5% or 10% level depending on the set of regressors considered. On the contrary economic upswings significantly increase market share variability for the whole sample but is not significant for the subsample. The result cannot just be explained by significant differences in the number of observation values for the two variables in each sample because indeed both have almost the same values. It is true that in both cases 75% of the values of ISVAR are positive It seems like a plausible explanation is that shocks in highly cartelized markets (50% of the total product-years) tend to break the discipline and disturb the short run equilibrium independently of the type of shock. The adjustment to the new equilibrium implies that some firms will increase their market

shares over the rest. In the case of the whole sample, because the proportion of cartelized markets is much lower (25% of the total product-years) upswings are more likely to disturb the oligopolistic equilibrium.

Table VI. Estimation results of market share variability[♦]

Independent Variable	***WHOLE SAMPLE***			***SUBSAMPLE***		
ISVAR		0.037 (0.079)	0.026 (0.079)		0.237* (0.132)	0.262** (0.133)
GROWTH		0.010** (0.004)	0.009** (0.004)		0.008 (0.007)	0.007 (0.007)
ENTRY		-0.044*** (0.015)	-0.044*** (0.015)		-0.046 (0.031)	-0.034 (0.034)
EXIT		-0.017 (0.014)	-0.019 (0.013)		-0.055*** (0.022)	-0.06*** (0.021)
IMPORT		-0.009 (0.012)	-0.001 (0.013)		-0.017 (0.019)	-0.011 (0.02)
GM			0.008** (0.004)			0.02** (0.009)
EXPORT		-0.004 (0.013)	0.002 (0.014)		0.005 (0.019)	-0.016 (0.023)
GX			0.003 (0.004)			-0.020** (0.008)
HORPF	-0.017*** (0.005)	-0.014*** (0.005)	-0.015*** (0.005)	-0.030*** (0.009)	-0.027*** (0.009)	-0.026*** (0.009)
VERT	0.004 (0.007)	0.006 (0.007)	0.007 (0.007)	0.023* (0.013)	0.022** (0.012)	0.030** (0.013)
BOTH	0.014* (0.009)	0.010 (0.009)	0.009 (0.008)	0.015 (0.016)	0.016 (0.014)	0.012 (0.016)
KSR		-0.005** (0.002)	-0.004** (0.002)		-0.033 (0.124)	-0.052 (0.123)
GKSR			-0.007* (0.004)			0.004 (0.006)
CONSTANT	0.014*** (0.009)	0.243*** (0.008)	0.237*** (0.009)	0.026** (0.012)	0.030** (0.014)	0.030* (0.017)
Log likelihood	1303.106	1315.372	1319.629	460.9689	469.9507	474.7976
Wald chi2	961.14***	958.59***	968.08***	329.14***	381.78***	421.65***

[♦]Standard deviations appear in parentheses below the coefficients.

The behavior of the market shares when there is entry or exit depends again of the sample under study. EXIT is associated with a negative coefficient at 1% level of significance for the subsample regression. This result may indicate how exit by increasing concentration, lowers instability. The coordination mechanism is reinforced. But our estimation result in the case of ENTRY is significantly negative which is in conflict with our initial predictions. The negative sign of the coefficient of ENTRY is significant at 1% level only in the whole sample. This result is in conflict with previous

results in the literature[18]. What are the possible explanations? We showed how the correlation between entry and HHI is very low, -0.07, thus entry does not lower foremost the level of concentration in the market, and thus it does not have a destabilizing effect on shares. A probit regression of CARTEL on ENTRY shows that it is positive, significant at 10% level, and the magnitude is 0.48.

The effect of the foreign trade variables follows the predictions. GM enters with a positive sign significant at 5% level. Increasing import instability does not necessarily increase variability in market shares, but increasing import penetration does. Exports only have a significant effect in the subsample. GX enters with a negative sign significant at 5% level. Thus disturbances are directed towards foreign markets. Overall the effect of export is weak

KSR and GKSR when significant, enter with the expected sign. The higher the capacity utilization of the firms the lower the possibilities to expand production possibilities when there are changes in the economic environment, therefore the lower is the instability of the market shares. But the magnitude of the effect is rather small.

6. Conclusions and policy implications

We postulated that share variability fluctuates among markets with the exogenous fluctuations of the short run equilibrium, the existence and choice of the organizational form of the cartel, and the structural characteristics of the markets. The proposed variables significantly and correctly captured the predicted effects. More importantly we found statistical support for the hypothesis that the existence of horizontal price-fixing cartels are significantly associated with lower market share variability as compared to those markets in which such agreements were absent. The conclusion is robust to the inclusion of other explanatory variables that plausibly affected market share instability. The result supports the idea that instability increases as collusion becomes less complete and effective.

What is the normative relevance of these results? Market instability per se does not indicate the existence of colluding behavior, which is not the conclusion of the

[18] See Caves and Porter (1978) and Gort (1963)

paper. A perfectly competitive market is precisely characterized by a low instability. Our recommendations are concerned with highly concentrated markets. Despite the limitations of the data, the results can be used as another tool available to antitrust authorities to call for a first approach to detect the existence of tacit collusion in industries with similar structure but significant differences in market share variability. That clearly implies that the authority should have at its disposal the required data to allow market structure comparisons.

References

Bernhardt, I. "Vertical Integration and Demand Variability", *The Journal of Industrial Economics*, Vol. XXV, No.3, March 1977.

Blair, R.D. and Kaserman D.L. *Antitrust Economics*, Irwin Publications in Economics, 1985

Caves, R.E. and Porter, M.E. (1978) "Market Structure, Oligopoly, and Stability of Market Shares", *The Journal of Industrial Economics*, Vol. XXVI, No.4, pp. 289-313

Ciarreta (2000), *A Study of Cartel Performance and Stability: The Swedish Experience*, Doctoral Thesis, SUNY at Stony Brook

Das, B.J., Chappell, W.F., and Shughart II, W.F. (1993) "Demand Fluctuations and Firm Heterogeneity", *The Journal of Industrial Economics*, Vol. 41, No.1, pp. 51-60

Donsimoni M.P. Geroski, P., and Jacquemin, A. (1984), "Concentration Indices and Market Power: Two Views", *The Journal of Industrial Economics*, No.4, Vol. XXXII, June 1984

Fershtman C. and Pakes A. (2000) A Dynamic Oligopoly with Collusion and Price Wars, *Rand Journal of Economics*, Vol. 31, No.2, 207-236

Fölster, S and Peltzman, S (1997) The Social Cost of Regulation and Lack of Competition in Sweden: A Summary. In *The Welfare State in Transition: Reforming the Swedish Model.* Freeman, Topel and Swedenborg Editors. The University of Chicago Press

Fraas, A.G., and Greer, D.F. "Market Structure and Price Collusion: An Empirical Analysis", *Journal of Industrial Economics* 26, pp. 29-33

Friedman, J. (1971) "A Non-cooperative Equilibrium for Supergames", *The Review of Economic Studies*

Geroski, P.A. (1982) "Interpreting a Correlation Between Market Structure and Performance", *The Journal of Industrial Economics*, No.3, Vol. XXX, March 1982

Gort, M., (1963) "Analysis of Stability and Change in Market Shares", Journal of Political Economy, 71, pp.51-63.

Green E.J. and Porter R.H. (1984) "Noncooperative Collusion under Imperfect Price Information"**,** *Econometrica*, Vol. 52, No. 1., pp. 87-100.

Hay, G. and Kelley, D. (1974), "An Empirical Survey of Price Fixing Conspiracies", *Journal of Law and Economics* 17, pp. 13-38

Jacquemin A., De Ghellinck E., and Huveneers, C. (1980), "Concentration and Profitability in a Small Open Economy", *The Journal of Industrial Economics*, No

Mills, D.E. and Schumann, L. (1985) “Industry Structure with Fluctuating Demand”, *Journal of Industrial Economics*, 33, pp. 57-71

Osborne, D. K. (1976) “Cartel Problems”, *The American Economic Review*, Vol. 66, No. 5, pp. 835-844

Palmer, J. (1972) “Some Economic Conditions Conducive to Collusion”, Journal of Economic Issue 6, pp. 29-38

Posner, R.A. *Economic Analysis of Law*, Fourth Edition, Little, Brown and Company, chapter10, pp. 285-321

Rotemberg J.J. and Saloner G. (1986), **“**A Supergame-Theoretic Model of Price Wars during Booms”, *The American Economic Review*, Vol. 76, No. 3., pp. 390-407

Scherer, F.M. (1970), *Industrial Market Structure and Economic Performance*, Rand McNally, Chicago.

Stålhammar, N.O. (1991) “Domestic Market Power and Foreign Trade”*, International Journal of Industrial Organization*, 9, 407-424

Statens Offtenliga Utrdningar (SOU)

Statens Pris och Konkurrensverk, (SPK), 1972, 1992 reports

Statistika Centralbyran, (SCB)

Stigler, G. (1964) “A Theory of Oligopoly”, *Journal of Political Economy*